APPENDIX 9-3

SENSITIVITY ANALYSIS FOR EAA RESERVOIR A-1 MODFLOW MODEL

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During development of the Reservoir A-1 MODFLOW model, hundreds of model runs were performed to determine the sensitivity to the many variables required by the model. This summary documents the findings of the sensitivity analysis.

1. ELEVATIONS OF AQUIFER INTERFACES

Since the interfaces of the aquifer formations are based on hundreds of boring logs, these elevations were not varied in the model with the exception of the bottom of the Tamiami Formation. Borings drilled throughout the reservoir area have not extended to the bottom of the surficial aquifer to define the location of the confining Hawthorn Formation, which should act as the maximum depth for seepage to migrate. According to available mapping from the USGS, the bottom of the surficial aquifer is approximately 210 to 220 feet below ground surface (Miller, 1987). Deep borings are planned for Work Order 9 to confirm this depth. The elevation of the bottom of the Tamiami Formation was varied in the model, and it was determined that seepage increased by about 20% to 40% by extending the surficial aquifer deeper.

1.1 Hydraulic Conductivity

Additional sensitivity analyses will be performed for the sets of hydraulic conductivity values determined by calibrating both MODFLOW and SEEP/W to the test cell results, and the USACE values determined from field and laboratory testing of the aquifer layers. However, preliminary sensitivity analyses indicate that the Reservoir A-1 MODFLOW model produces similar seepage quantities using all 3 sets of K values, as shown in Table 6-3.1. The seepage rates given in the table are only for comparison purposes. The seepage rates have changed because the model has evolved since this sensitivity analysis was performed.

The EAA Reservoir A-1 model appears to be more sensitive to the vertical hydraulic conductivities of the muck, caprock, Fort Thompson, and Caloosahatchee than the horizontal hydraulic conductivities of these layers. The model appears to be quite sensitive to very low hydraulic conductivities of the muck layer. However, because of the large network of canals that are cut through the muck throughout the reservoir site, low hydraulic conductivity values for the muck layer are probably not justified. Through testing performed on samples of the muck, the USACE found K_h=40 ft/day and K_v=9 ft/day (USACE, 2005). By using these values in the Reservoir A-1 MODFLOW model, the seepage is nearly cut in half. The model does not appear to be very sensitive to the vertical or horizontal hydraulic conductivities of the Tamiami Formation.

1.2 Boundary Conditions

The Reservoir A-1 model was evaluated under several boundary conditions. The model produced the same result with both constant heads and no-flow boundary conditions for the Miami and Hillsboro Canals, indicating that the boundaries were chosen far enough away from the reservoir to have no impact on the seepage estimates.

1.3 Seepage Canal

The seepage canal was modeled using various MODFLOW packages including the river, drain, and specified head packages. The seepage results were very similar with all packages.

The model shows seepage increases slightly with a deeper seepage canal, but the canal captures a larger percentage of the seepage.

1.4 Canal Conductance

The conductance term defines the degree of interaction between the surface water canals and the underlying aquifer. It is one of the least understood values in groundwater modeling. For this evaluation, the canal conductance was assumed to be 100 ft^2/ft/day, based on an assumed 1 ft canal sediment thickness and a sediment hydraulic conductivity of 1 ft/day. This is the same value used by the USACE and it was also used during the design of STA 3/4. Fortunately, the model does not appear to be very sensitive to the conductance term used for the canals.

1.5 Cutoff Wall

A deeper cutoff wall will reduce total seepage from the reservoir, but it also forces seepage to extend deeper into the surficial aquifer reducing the percentage of seepage that is collected by the perimeter canal.

1.6 Water Levels in the Reservoir, Canals, and Surrounding Areas

Modeling confirmed that seepage from the reservoir will be at its maximum when the reservoir is full of water and the water levels in the surrounding canals, farm lands, STAs, and Holey Land are low because the head differential will be the greatest during these times. Also, as the seepage collection canal is drawn down, more seepage will occur from the reservoir.

A sensitivity analysis was also performed by adding several of the farm canals to the MODFLOW model to the northwest and northeast of the reservoir site. It is not possible to add all of the individual farm canals to the model because there are too many of them. However, just by adding a few of the farm canals and applying a constant head to the top layer of the model, it was shown that the farm canals are very effective at controlling groundwater heads even in the lower portions of the aquifer.

TABLE

Table 1 Sensitivity to Various Sources and Combinations of Hydraulic Conductivity Values

Model Run	Reservoir Depth (ft)	Cutoff Wall Depth (ft)	Source of K Values	Total Seepage* (cfs)	Seepage Lost* (cfs)	Seepage Lost* (% of total)
1	12	2	MODFLOW	800	236	30%
2	12	8	MODFLOW	770	228	30%
3	12	33	MODFLOW	552	180	33%
4	12	68	MODFLOW	192	105	55%
5	15	33	MODFLOW	673	222	33%
6	15	68	MODFLOW	234	127	54%
7	18	33	MODFLOW	794	265	33%
8	18	68	MODFLOW	277	150	54%
9	12	2	SEEP/W	828	238	29%
10	12	8	SEEP/W	736	213	29%
11	12	33	SEEP/W	414	158	38%
12	12	68	SEEP/W	181	100	55%
13	15	33	SEEP/W	505	193	38%
14	15	68	SEEP/W	221	122	55%
15	18	33	SEEP/W	596	228	38%
16	18	68	SEEP/W	260	144	55%
17	12	2	MODFLOW with USACE Tamiami	715	167	23%
18	12	8	MODFLOW with USACE Tamiami	685	158	23%
19	12	33	MODFLOW with USACE Tamiami	469	110	23%
20	12	68	MODFLOW with USACE Tamiami	191	45	24%
21	12	2	SEEP/W with USACE Tamiami	749	176	23%
22	12	8	SEEP/W with USACE Tamiami	656	153	23%
23	12	33	SEEP/W with USACE Tamiami	332	95	29%

Model Run	Reservoir Depth (ft)	Cutoff Wall Depth (ft)	Source of K Values	Total Seepage* (cfs)	Seepage Lost* (cfs)	Seepage Lost* (% of total)
24	12	68	SEEP/W with USACE Tamiami	152	46	30%
25	12	2	USACE Values, without muck	691	155	22%
26	12	8	USACE Values, without muck	652	143	22%
27	12	33	USACE Values, without muck	595	127	21%
28	12	68	USACE Values, without muck	236	41	17%
29	12	2	USACE Values, with muck	370	37	10%
30	12	8	USACE Values, with muck	365	37	10%
31	12	33	USACE Values, with muck	351	36	10%
32	12	68	USACE Values, with muck	194	22	11%
33	12	2	MODFLOW with USACE Muck and Tamiami	483	85	18%
34	12	8	MODFLOW with USACE Muck and Tamiami	478	84	18%
35	12	33	MODFLOW with USACE Muck and Tamiami	382	76	20%
36	12	68	MODFLOW with USACE Muck and Tamiami	177	38	21%
37	12	2	SEEP/W with USACE Muck and Tamiami	570	117	21%
38	12	8	SEEP/W with USACE Muck and Tamiami	548	117	21%
39	12	33	SEEP/W with USACE Muck and Tamiami	309	86	28%
40	12	68	SEEP/W with USACE Muck and Tamiami	147	44	30%
* Seepage rates are for comparison only – seepage rates have changed because the model has evolved since this sensitivity analysis was performed						